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A UNIQUE TECHNIQUE FOR STREET TREE PLANTING IN BEIJING

Jun Yang and Joe McBride***

Summary

This paper presents a unique technique that urban foresters in Beijing used to plant more street trees. This technique involves the transplanting of heavily pruned, relatively large size trees into sidewalk cuts along major streets. The benefits and the disadvantages of this type of planting are discussed. A long term, well-designed field test is recommended before this new planting technique is applied on a large scale.

Keywords: street trees • transplanting

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Introduction

Street trees are the showpiece of the urban forest in many cites. Horsechestnut trees (*Aesculus hippocastanum* L.) line the boulevards in Paris; beautiful maidenhair trees (*Ginkgo biloba* L.) along the streets of Tokyo make a strong impression on its visitors. Besides their amenity value, street trees provide shade in the summer, absorb the air pollutants, and reduce noise level along street. Planting and maintaining a well structured, functional street tree population can greatly improve the environmental quality of the urban environment (McPHERSON et al., 1997). However, this is not an easy job. The harsh environment on the street is quite different from a park and a backyard. A newly planted street tree will face hot, dry, polluted air, compact soil and sometimes, vandalism. Various methods are used to assure the success of a street tree planting programme. These include the selection of more tolerant tree species, good transplanting practice, careful preparation of the planting site and after-planting care. In spite of efforts to increase successful planting, not every tree survives. Furthermore, the benefits associated with street trees are often delayed for many years until the trees reach appropriate size. New ways are continually being developed to help urban foresters achieving better planting results. Recently, during a field survey of the urban forest in Beijing,

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FIGURE 1. A Japanese pagoda tree (*Sophora japonica* L.) planted in a roadside green space, Beijing. Notice the percentage of canopy cut off and the large d.b.h size (26.5 cm).

China, we found that the local urban foresters are using a unique technique to plant street trees along the main streets and in parks. In this practice, all branches were cut off from the trunk and the root systems severely cut back before a tree was transplanted from other sites in the city or from nearby nurseries. The remaining roots were not root-balled during transport. The transplanted tree must be considered as 'bare root stock', see Figure 1.

This method was used to transplant trees of various sizes, ranged from normally used 8 cm caliper poles up to a tree as large as 30–40 cm in d.b.h. The large scale of this kind of planting in Beijing is impressive as it is being used on almost every newly expanded street. Also, this method was applied with many major street tree species used in Beijing, including *Fraxinus* spp., *Salix* spp., *Acer* spp., *S. japonica*, and *Koelreuteria paniculata* Laxm.

Study Area

Beijing, the capital city of China, was the site of this study. Beijing has a population of 11 million and a built up area of 733.16 km^2. It is characterized as a warm temperate continental monsoon climate. The annual average temperature is 11.5°C, with an average precipitation of 630 mm. In this study, three streets were picked up for investigation. They are Xueyuan and Xueqing Avenues in the Haidian District and Dewai Street in the Xuanwu District. These two districts are in the central part of the city, the most crowded area.

Methods

The three streets were chosen from many newly planted streets. Two of the most commonly used street tree species in Beijing were planted on these three streets at the beginning of April, 2002. On Xueyuan Avenue and Dewai Street, *S. japonica* was used. On Xueqing Avenue, *Fraxinus chinensis* Roxb had been planted.

A 1.5 km long section of each of the streets identified above was chosen for the study. The condition of each recently planted tree in the 1.5 km section was ranked as good, fair, poor, or dead (see Figure 2) based on the criteria shown in Table 1.

These rankings and the measurements described below were taken during the end of June 2002, approximately 11 weeks after the tree had been planted. In addition to ranking the condition of all trees in the 1.5 kilometres section, 50 trees were selected at random in each section to determine the average size of the planted trees. A table of random numbers was used to select those sample trees. The height, diameter at breast height (d.b.h.), and the length of the longest sprout were measured on each randomly selected tree. The measurements were averaged to determine the average size of the transplanted trees and the average length of sprout produced half way into the first growing season after transplanting.

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TABLE 1. Criteria for class classification

Class	Description
Good	Strong sprouting, maximum length of sprouts > 1m, volume of sprouts > $1m^3$
Fair	Sprouting fairly well, maximum length of sprouts < 1m, volume of sprouts < $1m^3$
Poor	Few sprouts, no apparent dominant new branches
Dead	No sprouts or sprouts were dead

FIGURE 2. Photos showing the four condition classes used for the Chinese ash tree: upper left -good condition; upper right -fair; lower left -poor; lower right -dead. The same criteria were used to rank the Japanese pagoda tree.

Results and Discussion

250 trees on Xueyuan Avenue, 200 trees on Dewai Street and 300 trees on Xueqing Avenue were investigated. The average d.b.h. and tree height of these trees is shown in Table 2.

TABLE 2. Average d.b.h (cm) and height (m) for trees in studied area

Street	Species	DBH	SE	Height	SE
Dewai	*Sophora japonica*	19.12	1.59	2.92	0.17
Xueyuan	*Sophora japonica*	12.07	2.36	2.62	0.10
Xueqing	*Fraxinus chinensis*	7.80	0.92	3.03	0.09

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TABLE 3. Distribution of street trees by condition on three streets (%)

Condition class	Deiwai Street	Xueyuan Avenue	Xueqing Avenue	Average for Study area
Good	48.0	40.8	43.3	43.7
Fair	40.5	20.0	7.0	20.3
Poor	11.0	9.2	12.4	10.9
Dead	0.5	30.0	37.3	25.1
All classes	100.0	100.0	100.0	100.0

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The result shows that trees in different sizes were used for planting different streets. The size of Chinese ash trees planted is considerately larger than the range regulated by the *Code for Planting Planning and Design on Urban Roads* (CHINA ACADEMY OF URBAN PLANNING AND DESIGN, 1997). The code requires that planted street trees should have a d.b.h. larger than 5cm for fast-growing tree species and 8 cm for slow-growing species. The Japanese pagoda trees used here are far above that standard. They are big trees rather than the commonly planted trees referred to as seedlings in Beijing. A proportion of the average 12 cm d.b.h. trees planted along Xueyuan Avenue was produced in the nursery. The rest of these 12 cm caliper trees and all average 19 cm caliper trees planted along Dewai Street were transplanted from a nearby old residential area, subsequently demolished. The result of ranking trees by condition class is shown in Table 3.

For the three streets investigated, less than 50 per cent of trees were classified as being in good condition. The mortality rates were higher on Xueyuan Avenue and Xueyuan Avenue than on Dewai Street. The greater survival of trees planted on Dewai Street may be due to their larger size trunk. A larger trunk can store more reserves of energy and food. PELTIER and WATSON (2000) pointed out that even under normal practice, a transplanted tree usually loses 85–90 per cent of its root system. In the case of these transplants, we expect more losses: When a tree has lost its canopy and most of its root system, its ability to produce new shoot and root tissue is dependent upon its reserve of carbohydrate and water. With more reserves, larger trees have a better chance of successfully renewing growth and surviving. On other streets which were planted using same treatment, with the same or different tree species, it is not difficult to find a large number of trees without sprouts. This study was conducted at the end of June, when established street and park trees have been fully in leaf for at least two months. However, most of trees planted with this special technique had just began to sprout, two months later than normal trees would be expected to produce leaf growth.

Compared to the street tree planting methods used in the US, the 'cut-all branches-off' technique seems radical. It violates the norms used by the American arborist. According to the *Tree and Shrub Transplanting Manual* published by International Society of Arboriculture (HIMELICK (1991)), only

trees with a well-formed top that are characteristic of the species should be planted. This manual also states a heavy pruning cut which removed 20–30 per cent of the branch after transplanting would be detrimental to trees. HARRIS et al. (1999) also point out that the main leader of tree should not be removed for most landscape purposes. By comparison, in the method observed in Beijing, 100 per cent of the branches were cut off. Actually, this kind of practice is not only against the American standard but also against the standard set by the Chinese government. In the *Code for Constructing and Monitoring of Urban Afforestation Projects*, it is clearly stated in section 8.0.2, Article 5 that trees used for street trees should keep its natural canopy form (TIANJING BUREAU OF LANDSCAPE AND GARDENING, 2001). This raises the question as to why this new technique is currently being used in Beijing. There are several possible reasons:

The technique can greatly reduce the cost of planting program

To reduce a tree into a bare trunk with a small bare root system makes it easy to transport and plant. There is no need to utilize equipment like a crane to lift the tree from ground and no necessity to protect the tree canopy and a large root ball. The standards of the planting pit can be lowered because there is no large root ball and heavy top. Moreover, there is no need for staking, the canopy is gone and tree can stand on its own. Any need for pruning after planting is also eliminated. All these conditions can lead to large savings on planting cost. Normally street tree planting is an expensive undertaking. MCPHERSON (1994) estimated that the average cost for planting a 2 inch caliper street tree in Chicago area cost $162 and another $97 is needed for pruning. The American Forest Association (AFA, 2002) reports an average cost of $300 for planting and maintenance of street trees during the first five years. Furthermore, if a larger caliper tree is required and planted, the planting cost will be much higher. The cost of planting and early maintenance of street trees can be expected to increase in the future with inflation. While the cost of street tree planting and maintenance increase, the budgets of most city street tree management departments are dwindling (TSCHANTZ and SACAMANO, 1994). In order to plant more trees with a limited budget, urban foresters are required to find ways to reduce the cost of planting.

Suitability for large scale planting in brief time periods

This technique is suitable for large scale plantings that have to be finished in a short time. There is no special requirement for equipment; little care of planting stock is needed during the process of transplanting the trees and there is a lower requirement for planting site preparation and after-planting care.

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Anyone who can use a shovel can plant a street tree. As a result a large area can be planted relatively quickly when a labour force is available.

A strong political will to push for rapidly increasing of the number of trees in Beijing

After Beijing won the right to hold the 2008 Olympic games, a slogan proposed by the Beijing government was to turn the Olympics into the 'Green Olympic Games'. An ambitious plan was adopted to increase the canopy cover from 43 per cent in 2000 to 50 per cent in 2008 citywide. There is now a great pressure from tree management departments to plant trees at an unprecedented speed. Big trees are preferred because of their suitability for large scale planting and their potential for developing canopies in a short time.

Cheap labour and planting materials make replacement of dead trees more cost effective than the investment necessary to achieve high survive rates associated with traditional tree planting

Labour in Beijing is inexpensive. Daily salaries for temporary workers used in tree planting programmes is at a rate of $4 to $8 (U.S. dollars). The retailer price for a 6 cm caliper Japanese pagoda tree is only $11, and for a 5 cm caliper ash tree, $8 dollars. If the seedlings are produced locally, from the city nursery, the cost is even lower. The large trees, like the 19 cm diameter Japanese pagoda trees used in Dewai Street, were coming from the demolished residential area. They are free of charge, because all of the trees in the city are thought of as public property. In the United States, a tree of such size may cost more than a thousand dollars. With the cheap labour and planting materials at hand in Beijing, it makes sense to allocate resources to plant more trees as fast as possible and periodically replace those that die with new trees. The North American-style of planting and planting after-care costs more and requires more skilled workers.

Recycling and reuse of trees originating from a demolished residential area

Currently, Beijing is experiencing dramatic changes all over the city. A large part of the residential area in the old city district was demolished to build new commercial and residential high-rise buildings. In these old residential areas, there are a large number of trees that have grown for many years, some for over a hundred years. It is impossible to keep them at the original sites. Equally, it would be a great pity to just dispose of them. The idea of recycling and reusing these trees in street tree planting program actually saves a large number of trees from being destroyed.

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FIGURE 3. Lines of maple trees (*Acer* spp.) planted on both sides of Zhong Guan Chun Dong Lu, Beijing. The full foliage of the Chinese white poplar tree (*Populus tomentosa* Carr.) forming a shadow on the right-hand side of the picture provides a dramatic contrast to the bare sticks of the maple tree.

No matter how suitable this kind of practice is for the current situation in Beijing, some disadvantages are obvious. A tree that experiences such a dramatic change faces many problems.

Reduce the amenity value of street tree

A disadvantage of this kind of practice is the poor visual appearance it creates. In the first year, the street tree-planting program only adds lines of sticks to the street. See Figure 3.

The heavy pruning of the transplanted trees can prevent them from growing back to a natural form. Because the whole canopy structure has been removed, it will take a long time for these trees to develop a functional canopy to provide a base for photosynthesis and the production of carbohydrates. Also, the heavy pruning eliminates some of trees' food and energy reserves (CLAIR-MACZULAJTYS et al., 1999). During the process of re-establishment, competition between the new sprouts and roots is intense. As the sprouts deplete more resources, the root system will have difficulty recovering from its loss during the process of transplanting. Problems with water and nutrient

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absorption during the recovery of the root system will result in slow growth for the tree overall.

Without a well-structured canopy, not only is the aesthetic value of street tree reduced, but also the environmental services that a street tree can provide are diminished. Shade protection from the scorching summer sun, interception of air pollutants and reduction of noise level are a function of a well-structured urban forest canopy.

Making the tree more vulnerable to the attack of disease and pests

A weak tree is more prone to the attack of diseases and pests. In the first two or three years following transplanting, the small canopy that developed is still unable to replenish the reserves that were depleted by its growth. In such a weakened condition, the tree cannot provide enough resources to deal with the attack from pests and diseases (CLAIR-MACZULAJTYS et al., 1999). An epidemic disease, like Dutch Elm Disease (DED), could potentially take a huge toll on trees planted by using this technique although the effects of DED in particular might be more drastic in the US and Western Europe than in China (see SMALLEY and GURIES, 2000). The technique also exposes heartwood to the pores of heart rotting fungus. Exposure of heart rot to infection in these trees could lead to problems of branch failure in the future.

Conclusion

The wide use of the 'cut all branches off' technique for street tree planting in Beijing is due to the lower cost for planting, cheap price of labour and availability of plant materials, and the strong political will to increase tree cover for the Olympics in spite of potential disadvantages in aesthetic and environmental values and the potential for future disease and pest problems.

At this stage, it is still too early to judge the success or failure of this kind of practice. Since street tree establishment is a long-term endeavour. Some latent influence of this treatment may only be visible in decades. What the urban foresters in Beijing should do at this stage is to develop an assessment programme of the cost and benefits of this unique technique for tree planting. A more cautious approach, based on a valid research programme, may in the long term be seen to result in a more functional and sustainable urban forest for Beijing.

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Résumé

Cet article présente une technique unique ayant été utilisée par les forestiers urbains de Beijing pour accroître la plantation d'arbres dans les rues. Cette technique implique la transplantation d'arbres de relativement grande taille, ayant subi un élagage sévère, dans des tranchées ménagées dans les trottoirs le long des rues principales. Les avantages et inconvénients de ce type de plantation se trouvent examinés. L'article recommande de procéder à un essai sur le terrain, qui soit bien conçu et à long terme, avant d'appliquer cette technique de plantation sur une grande échelle.

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